CLAIMS

1. An NO_x discharge quantity estimation method for an internal combustion engine equipped with an EGR apparatus for circulating to an intake passage of the engine a portion of exhaust gas flowing through an exhaust passage of the engine, characterized in that a quantity of NO_x contained in exhaust gas discharged from the exhaust passage to the outside is estimated on the basis of a quantity of NO_x generated in a combustion chamber as a result of combustion and a quantity of NO_x circulated into the combustion chamber via the EGR apparatus.

2. An NO_x discharge quantity estimation method for an internal combustion engine equipped with an EGR apparatus for circulating to an intake passage of the engine a portion of exhaust gas flowing through an exhaust passage of the engine, characterized by comprising the steps of:

estimating a combustion region, the combustion region being a region of the combustion chamber in which combustion occurs;

estimating, as a combustion-generated NO_x quantity, a quantity of NO_x generated within the combustion region as a result of combustion, and an NO_x quantity in a non-combustion region, the non-combustion region being the remaining region of the combustion chamber; and

estimating, on the basis of the combustion-generated NO_x quantity and the NO_x quantity in the non-combustion region, a quantity of NO_x contained in exhaust gas discharged from the exhaust passage to the outside.

3. An NO_x discharge quantity estimation method according to claim 2, wherein the NO_x quantity in the non-combustion region to be estimated is a non-combustion-region circulated NO_x quantity which represents a quantity of a portion of NO_x circulated into the combustion chamber via the EGR apparatus, the portion of the circulated NO_x being present in the non-combustion region before combustion.

4. An NO_x discharge quantity estimation method according to claim 2, wherein when a combustion-region circulated NO_x quantity is greater than the combustion-generated NO_x quantity, the combustion-region circulated NO_x quantity is employed as the combustion-generated NOx quantity, wherein the combustion-region circulated NO_x quantity represents a quantity of a portion of NO_x circulated into the combustion chamber via the EGR apparatus, the portion of the circulated NO_x being present in the combustion region before combustion.

5. An NO_x discharge quantity estimation method according to claim 2, further comprising the steps of:

estimating an NO_x concentration of exhaust gas on the basis of the combustion-generated NO_x quantity and the NO_x quantity in the non-combustion region; and

estimating the quantity of NO_x discharged from the exhaust passage to the outside by multiplying the NO_x concentration by a quantity of exhaust gas discharged from the exhaust passage to the outside.

6. An NO_x discharge quantity estimation method according to claim

5, wherein the quantity of exhaust gas discharged from the exhaust passage to the outside is estimated to be equal to a quantity of new air taken in the intake passage.

7. An NO_x discharge quantity estimation method according to claim 2, further comprising the steps of:

estimating a quantity of oxygen taken in the combustion chamber and a quantity of oxygen consumed by combustion; and

estimating the combustion region on the basis of a ratio of the quantity of oxygen consumed by combustion to the quantity of oxygen taken in the combustion chamber.

8. An NO_x discharge quantity estimation method according to claim 7, wherein the quantity of oxygen taken in the combustion chamber is obtained by multiplying an oxygen concentration of gas taken in the combustion chamber via an intake valve by a total quantity of gas taken in the combustion chamber.

9. An NO_x discharge quantity estimation method according to claim 7, wherein the quantity of oxygen consumed by combustion is determined under the assumption that all injected fuel burns completely at the stoichiometric air-fuel ratio.

10. An NO_x discharge quantity estimation method according to claim 2, wherein

the internal combustion engine is configured to effect, in each

operation cycle, at least one pilot injection and then main injection; and

the combustion-generated NO_x quantity is estimated in consideration of influences of an inert gas generated as a result of the pilot injection.